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Lodgepole Needle Miner

By George R. Struble, forest entomologist, California Forest and Range Experiment Station [1]

The lodgepole needle miner (*Recurvaria milleri* Busck) is one of the most important insect pests of lodgepole pine in some of California's most scenic mountain forests. The caterpillars of this small, inconspicuous moth feed within the pine needles. Under outbreak conditions, they become so numerous that they destroy every needle on trees larger than sapling size. Successive attacks weaken the pines; defoliation alone often kills them, but frequently mountain pine beetles (*Dendroctonus monticolae* Hopk.) attack and kill the weakened trees (fig. 1). This combination, rather than defoliation alone, is nearly always responsible when lodgepole pines affected by needle miner outbreaks are killed over large areas.

Within a few years, the dead, bleached snags present a weird spectacle that has been aptly termed a "ghost forest." Some of the snags stand for 30 or more years (fig. 2). Others drop away gradually into a crisscross of logs, which is a well-recognized fire hazard.

Outbreaks are known to have occurred in the southern Sierra Nevada at least three times since 1900. The most recent one started about 1945 in Yosemite National Park, Calif. By 1955 it had spread over 50,000 acres in the Tuolumne River Basin, Tuolumne County—where the insect was discovered—and in adjoining forests in the Merced River headwaters, Mariposa County. Other recent outbreaks in the Kings River and Kern River watersheds in Fresno and Tulare Counties have caused severe damage on an additional 4,000 acres since 1945.

Range and Hosts

The lodgepole needle miner is native to the high elevation forests in the Tuolumne, Kings, and Kern River watersheds of California. It is most prevalent and destructive at elevations between 8,000 and 10,000 feet. Lodgepole pine is the favored host, and ordinarily the needle miner does not attack other trees. Sometimes, however, when the caterpillars have mined all the lodgepole foliage, they migrate and attack other coniferous trees growing nearby. Such attacks have been recorded on Jeffrey pine, western white pine, and mountain hemlock.

Needle miner outbreaks occur predominantly in old, overmature stands. In these stands the younger lodgepole, saplings and larger, are often severely defoliated. Most of

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Figure 1.—Lodgepole pine forest killed by lodgepole needle miner and mountain pine beetle in 1920.

them recover after an epidemic subsides, but they usually show a sharp reduction in growth.

Other species of needle miners, similar in habit to *Recurvaria milleri*, attack lodgepole pine in different parts of its range. Two that are pests of lodgepole forests in the mountains of western Canada have recently been determined to be separate species.

Evidence of Infestation

Changing color of foliage is the most dramatic evidence of needle miner activity in lodgepole pine forests. Caterpillar feeding causes the foliage to turn first yellow, then red brown. Later the mined foliage falls and the stands take on a gray-bronze cast. The discoloration is most noticeable in May and June of odd-numbered years, when affected trees look from a distance as if they were scorched. On close inspection, individual trees show varying degrees of dying and dead foliage, mostly in the latest whorl of needles.

Affected needles held before a light appear to be hollowed out. One or more small holes, often covered by silken webs, are plainly visible. Under good lighting, a single caterpillar or a pupa may be seen within the needle (fig. 3, *A*, right).

Continued heavy attacks by needle miners shorten the foliage and reduce the number of needles (fig. 4). Tree crowns become sparse, and after two or three generations of miners attack the trees, only the shortened terminal foliage remains. Short internodes, dead and dying twigs, and dying branches are characteristic after feeding by three to four generations of needle miners.

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Figure 2.—This young lodgepole pine forest was heavily infested by the needle miner in 1953. The pines are growing among snags of an earlier kill.

Life Stages

Lodgepole needle miner eggs are ovoid, flattened, and barely visible without the aid of a hand lens. The color is lemon yellow at first, but deepens. After about 30 days of incubation, the black heads of the newly formed larvae are visible through the egg sac.

The larval or caterpillar stage (fig. 3, *B*) varies from lemon yellow to deep reddish orange in all 5 instars during 21 months of development. In size, larvae vary from about one twenty-fifth of an inch long in the first instar to about one-third of an inch at pupation.

The pupae (fig. 3, *C*) are black and slightly larger than the adults

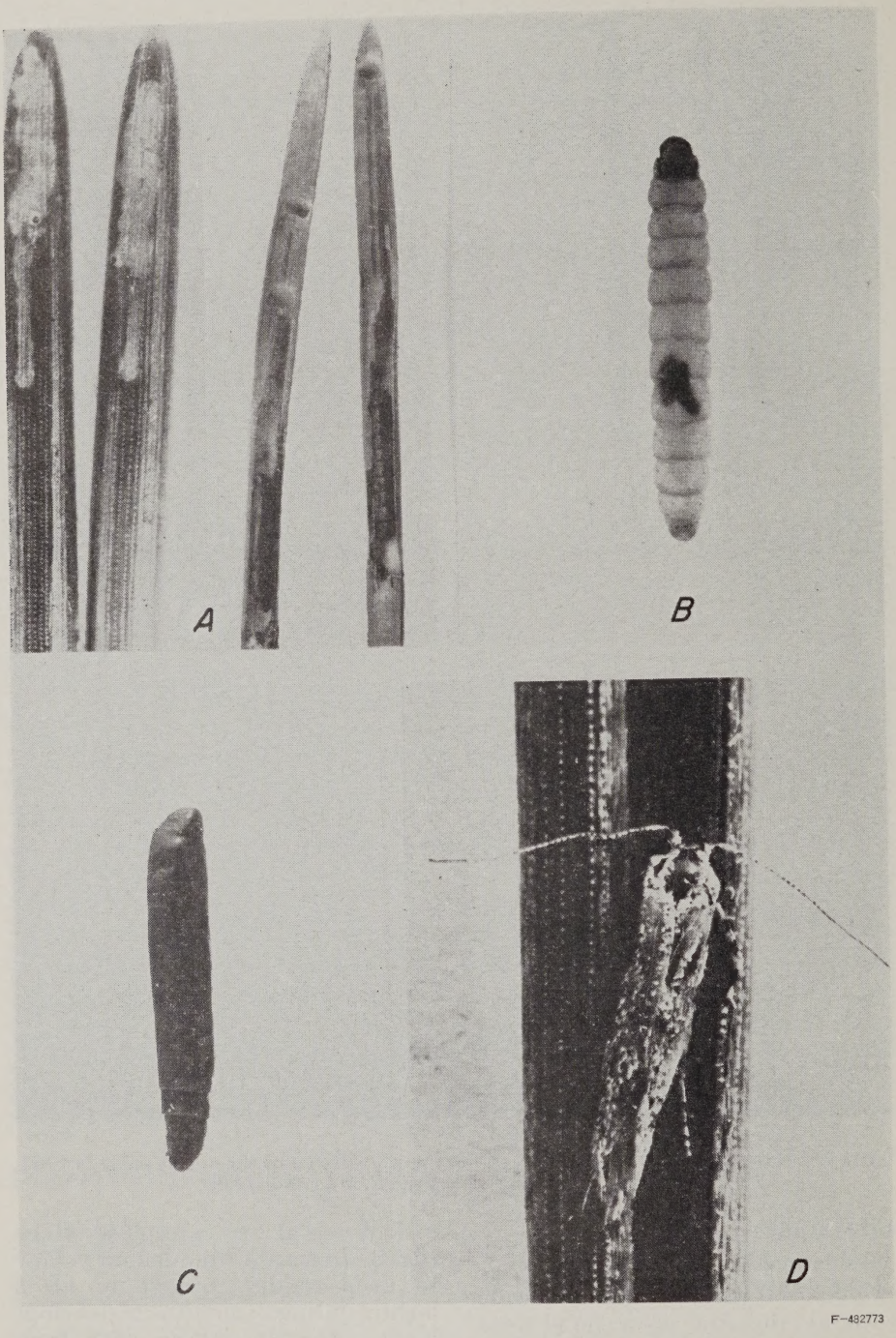

Figure 3.—Life stages of the lodgepole needle miner. *A*, Mined needles showing, left, entry holes at early stage of larval activity and, right, hollowing by advanced stages prior to pupation. *B*, Larva in fourth instar. *C*, Pupa. *D*, Adult moth. Larva, pupa, and adult moth are about one-fourth inch long.

(fig. 3, *D*). The pupal stage is quiescent and lasts about a month.

Needle miner adults are small, rapidly moving, gray moths, about one-fourth inch long. They emerge, fly, mate, and lay eggs only in odd-numbered years from mid-July to the end of August.

Biology and Habits

One remarkable feature of the lodgepole needle miner is the regularity of its life cycle and outbreaks. There is no record of overlapping or off-season breeding. Neither is there a record of outbreaks at different time intervals in different places. They have all occurred at about the same time, in odd-numbered years. Each outbreak has lasted about 10 years and has been followed by an approximately equal period of relative inactivity.

Most of the eggs are laid from the last of July through the third week in August. They are deposited in loosely bound groups of 2 to 15 or more, rarely singly. More than 60 percent of the eggs are deposited in needles containing old mines. Other favored locations are behind the bud scales of the current and previous year's growth. Sometimes eggs are deposited near the bases of new needles or between new needles.

The incubation period averages 35 days, ranging from 27 to 50 days. The eggs hatch in September, and the newly emerged larvae quickly migrate and bore into individual needles. They select foliage 2 or more years old in preference to younger needles.

Each larva enters a needle ¼ to ½ inch back of the apex along the curved outer surface. Entries are rarely made along the flat inner surface (fig. 3, *A*, left). Usually only a single larva enters a needle. An entry is completed within 24 to 48 hours. By the first week in October, all new larvae have bored into foliage where they remain feeding until winter, when they become dormant. They resume feeding in the spring, each larvae extending its mine in the needle it lived in over winter.

Migration to new foliage starts in mid-July, as developing larvae reach the third instar, and continues at an increasing tempo until mid-September. In the fourth instar (fig. 3, *B*), they often bind the two needles in a fascicle together with fine silk, then bore alternately from one needle to the other. Each larva mines two or more needles during the fall before the second winter dormancy. In the second spring it mines one or more additional needles before reaching the fifth or prepupal instar. Thus, each larva mines at least five needles before pupation.

The pupae remain in the last-mined needles. The average period in the pupal stage is 30 days. A week to 10 days after the moths emerge they reach sexual maturity (the sex ratio is 1:1). Mating and egg laying take place just after sundown and into darkness. Greatest activity occurs at temperatures between 55° and 60° F., from sundown to 9:30 p. m.

Needle miner populations differ greatly within an outbreak area, depending on the period the insect has been active in a given locality. In older infestations only the last two whorls of foliage remain on a twig. The number of caterpillars found there may vary from less than 15 to more than 60. Infestations that develop in previously uninfested stands nearby often contain up to 150 larvae in the 5 most recent whorls of foliage on a twig. Here the needle miners tend to concentrate in the older foliage, most of which is killed in a single generation.

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Figure 4.—Sparse, short foliage and numerous dying twigs on a lodgepole branch, the result of feeding by five generations of needle miners.

Control

Natural control factors undoubtedly keep the lodgepole needle miner from becoming epidemic throughout most of the range of lodgepole. However, the factor or group of factors that prevents the insect from becoming destructive is not known.

The needle miner has many natural enemies, including insect parasites and predators, and at least one disease, a granulosis virus. Its insect enemies include members of 16 families representing 42 genera. Six of these genera are known parasites, and two have occurred consistently in successive needle miner generations. Parasites have been considered important in controlling some outbreaks, but they do not seem to be a dominant factor. No significant control by disease organisms has been observed, although a high incidence of granulosis virus among the larvae was found in one area in 1953.

Conventional spray materials and methods that have been effective against many other forest defoliators have proved of little value in controlling the needle miner. Aerial applications of DDT at rates that ordinarily control pests such as the spruce budworm and Douglas-fir tussock moth have been ineffective against the needle miner.

Recent tests have shown that dieldrin, endrin, or malathion sprays will control the needle miner if a large enough quantity of spray is used. Two pounds of insecticide dissolved in Number 2 fuel oil and applied at the rate of 20 gallons per acre is recommended. The spray should be put on when

the needle miner is in the larval stage. Care should be taken to cover the entire crown surface of the tree. In areas accessible by roads, spraying can be done with a truck- or trailer-mounted mist blower. As yet, no satisfactory method of applying these dosages to control needle miner infestations over large or remote forest areas has been developed.

CAUTION: The insecticides recommended are relatively safe to use, but they contain toxic chemicals and therefore should be handled with care. Spray formulations should be mixed in the open to reduce the danger of inhaling poisonous materials. In case of accidental spillage, wash exposed skin thoroughly with soap and water. In forest spraying, avoid overdosing in the vicinity of streams, ponds, and lakes.

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